



# **City of Chicago**

## **Department of Fleet Management**

***Leading the Way to Cleaner Air***

### **Chicago's Fleet Modernization Program**



# **City of Chicago**

## **Department of Fleet Management**

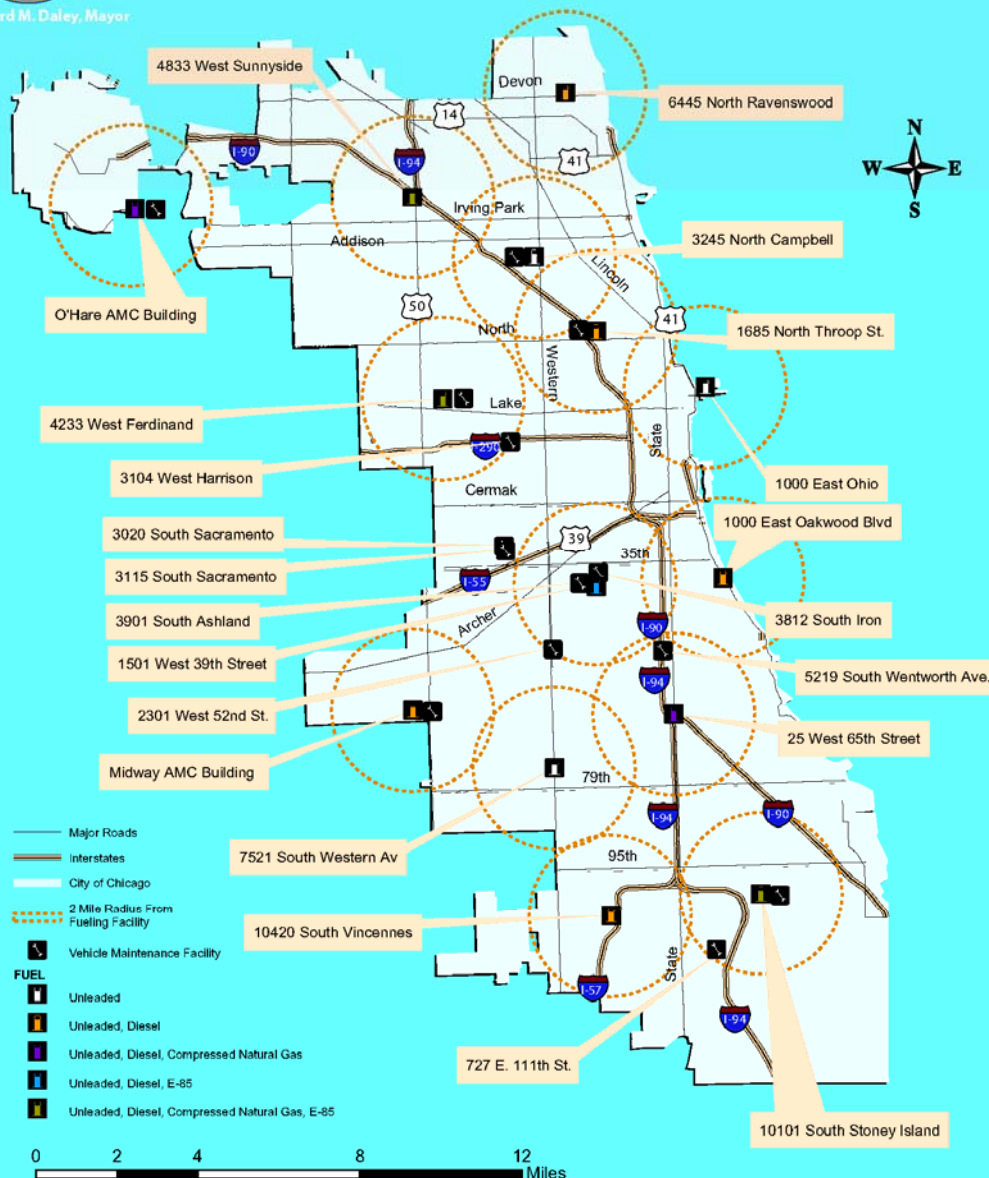
### **Who we are . . .**

- **11,400 pieces of equipment**
- **48 Customer Departments**
- **820 Employees**
- **110,000 Work orders annually**
- **13 Maintenance Locations**
- **12 Fuel Sites**
- **11 Million Gallons of Fuel Dispensed**



Richard M. Daley, Mayor

# Department of Fleet Management Vehicle Maintenance and Fuel Facilities



Department of Fleet Management  
Howard J. Henneman  
Commissioner



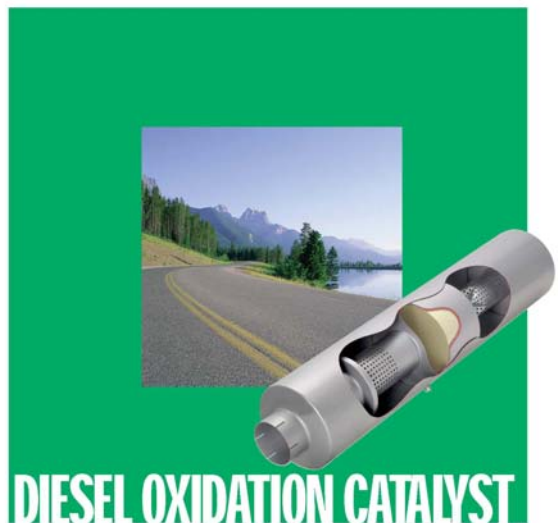
# Refuse Trucks



- 4 units equipped with Particulate Filters (up to 98% emissions reduction).
- 76 units equipped with oxi-cats (up to 60% emissions reduction).
- Remainder of Front Line Fleet (370 units) will be equipped with oxi-cats in 2006.



# Fleetguard Oxi-Cats (DOCs)



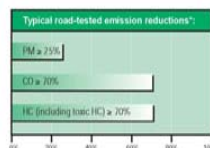
## DIESEL OXIDATION CATALYST

Engineered for retrofit to meet tough clean air standards, the DOC breathes new life into diesel engine exhaust systems with EPA-verified technology and proven on-the-road success.



A world leader in emissions and filtration technology

Reducing emissions from diesel exhaust doesn't have to be complicated. Fleetguard Emission Solutions makes it simple with a Diesel Oxidation Catalyst (DOC) designed to retrofit existing vehicles. Easy to install and maintenance free, the DOC is reducing emissions from on-road vehicles and off-road equipment around the globe, cost effectively and efficiently.



The DOC may either replace or be added to the existing vehicle muffler, and may be applied to a wide variety of diesel engines. Versatile and flexible, the DOC:

- Easily installs
- Needs no maintenance
- Requires no monitoring
- Can be used with low sulfur (<50 ppm) or ultra low sulfur diesel fuels (<15 ppm)
- Is available in a variety of shapes and sizes
- Readily adapts to many applications
- Cannot be used with fuel oil blending systems
- May be used in a catalytic exhaust muffler to reduce noise as well as emissions

### GOING RETRO

Engines around the world are driving cleaner with the Fleetguard Emission Solutions DOC

■ Urban Buses	More than 32,000 in Asia, Europe and the U.S.
■ Medium & Heavy-duty Trucks	More than 1 million
■ Heavy-duty Vehicles	More than 6,000 in Mexico
■ Medium-duty Diesels	Approximately 20,000 in Hong Kong

LTN035  
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Diesel Oxidation Catalyst

### Retro Fits!

Fleetguard Emission Solutions has vast experience in retrofitting a variety of applications:

- Urban Transit Buses
- School Buses
- Refuse Collection Vehicles
- Government Fleets
- Off-highway Equipment
- Private Fleets

### Connect to a world of diesel expertise

Fleetguard Emission Solutions provides technologies to protect your fleet and keep it running clean and strong. We are committed to developing superior products that meet or surpass emission regulations. Supported by the Cummins North American distributor network and Fleetguard worldwide, our systems bring real value to you - from installation through the life of the product. From funding options for retrofit projects to providing support years down the road, we're with you for the long haul.

Choose the emission reduction leader backed by the Cummins legacy of technology for your complete fleet needs. Choose Fleetguard Emission Solutions.

For more information, contact Customer Assistance at 1-800-22-FILTER (1-800-223-4583), fax 1-800-999-8664 or visit us at [www.fleetguard.com](http://www.fleetguard.com)



**International Truck & Engine Corporation**  
Green Diesel Technology™ by International®

### Diesel Particulate Filter (DPF)



International® diesel particulate filters utilize the latest advancements in emission control technology from Engelhard, a world leader in emission technology.

#### Retrofit filters provide:

- 70-98% reduction in particulate matter (PM) and visible smoke, depending on fuel quality
- 70-98% reduction in CO and HC
- Reduced odor
- Reduced noise

Diesel particulate filters from International are passive systems and allow oxidation of PM at normal operating temperatures.

#### Benefits include:

- Fuel sulfur tolerance. Although we require the use of ultra low sulfur fuel (15ppm), occasional use of higher sulfur fuel in emergency situations will not damage the system or stop the vehicle.
- Easy cleaning and maintenance. We recommend cleaning and visual inspection once every (12) twelve months or every 80,000 miles/130,000 kilometers. Certain applications may require more frequent service. International systems include a pressure monitor sensor, which will indicate the need for cleaning. Only removal of the non-toxic ash is required to clean the filter.
- No additional energy devices. DPF systems are designed to be passive systems and regenerate under normal vehicle operating conditions.
- Effective under most driving conditions. Idling does not substantially affect the performance of the DPF. During idling, very little PM is produced, and the PM that is produced is primarily oil and fuel that the DPF easily eliminates.
- Adaptability. The DPF is available for use on most diesel buses and medium trucks with electronic

### Diesel Oxidation Catalyst (DOC)



International® diesel oxidation catalyst is OEM engineered and built.

#### Retrofit catalyst provide:

- 20-30% reduction in particulate matter (PM)
- up to 50% reduction in carbon monoxide (CO) and hydrocarbons (HC)
- Harmful hydrocarbons (HC) are also reduced up to 50%

Recommended for mechanical engine vehicles that do not qualify for the DPF.

#### Benefits include:

- Proven low cost emissions reduction technology
- Easy to install and requires no maintenance after installation.
- The muffler and catalyst are combined to provide sound attenuation and emission reduction capabilities.

Green Diesel Technology™ by International® retrofit products have been Verified by The Federal EPA and eligible for Federal and most state and local grant funding. Manufactured with Stainless Steel materials for durability and corrosion resistance. Meets U.S. Federal on-highway vehicle noise regulations. Additional information, can be found on the EPA website at [www.epa.gov](http://www.epa.gov).

### FOR BUSINESS AND THE ENVIRONMENT

Today in the U.S., almost all heavy trucks, medium trucks and buses are powered by diesel. And it's not just because of diesel's unsurpassed power and performance. There are a few more reasons. Green Diesel Technology® vehicles developed by International and I/C Corporation, International's wholly-owned affiliate, are the way of the future. Using the breakthrough advantages of advanced diesel engine technology, particulate filters and ultra-low-sulfur diesel fuel, some engines developed by International have already been certified as meeting the U.S. Environmental Protection Agency's 2007 standards for particulate matter (PM) and hydrocarbons (HC). And there's even more improvement on the way. International's retrofit kits are another part of the emission improvement line of products offered through all authorized International and I/C bus dealer locations. You can rest assured all federal guidelines will be met - and that we'll continue to provide you with clean trucks and buses that move you ahead, on the road and in your business.

(370 refuse trucks in 2006)



# Street Sweepers



- 4 units equipped with Particulate Filters (Up to 98% emissions reduction)
- More than 50 of 117 units will be equipped with oxi-cats in 2006

# Engelhard Particulate Filters (DPFs)

## 4 sweepers and 4 refuse trucks



ENGELHARD

### DPF

Catalyzed diesel particulate filter for heavy duty diesel emissions control

#### Technology Profile

To meet the US 2007 heavy duty diesel emissions regulations, many engine manufacturers are using a catalyzed diesel particulate filter (DPF) integrated into an active regeneration system for particulate reduction, combined with engine tuning for  $\text{NO}_x$  reduction (see figure 1).

#### Diesel particulate filters

As the name implies, DPFs remove particulate matter in diesel exhaust by filtering exhaust from the engine. Since a filter will fill up over time a means of burning off or removing accumulated particulate matter is required. The leading method for burning the accumulated particulate matter is to utilize a catalyst applied to the filter substrate. A number of filter substrate designs and materials have been used for diesel particulate filters including: ceramic and silicon carbide materials, fiber wound cartridges, knitted silica fiber coils, ceramic foam, wire mesh, sintered metal substrates, and temperature resistant paper in the case of disposable filters.

#### Efficiency

Collection efficiencies of these filters range from 50 to over 90 percent. Currently the Wall Flow Filter (WFF) is the industry standard. With the applied catalyst, the filter will cap-

ture well over 90% of the total particulate matter (TPM) and catalytically oxidize the TPM, hydrocarbons, and carbon monoxide.

#### DPF operation

A typical diesel particulate filter is shown in figure 2. Particulate-laden exhaust enters the filter. Because the cells of the filter are capped at the downstream end, exhaust cannot exit the cell directly. Instead, exhaust gas passes through the porous walls of the filter cells. In the process, particulate matter is deposited on the upstream side of the cell wall. Cleaned exhaust gas exits the filter.

#### Oxidizing TPM

A typical DPF utilizes a combination of a precious metal (typically platinum) and a base metal oxide (BMO - like cerium oxide) to oxidize the TPM. The mechanism for oxidizing TPM is shown in figure 3.

#### DPF system

With the ongoing concern about the effects of diesel particulate, the catalyzed particulate filter is an excellent option for eliminating virtually all of diesel engines particulate emissions. This system allows the engine manufacturer the flexibility to produce an engine that is actually cleaner in particulates than a natural gas engine. Additionally since the

catalyst is similar in composition to the current automotive catalysts there is a recycling system in place for recovering the precious metal.

#### About Engelhard

Engelhard Corporation is a surface and materials science company that develops technologies to improve customers' products and processes. A Fortune 500 company, Engelhard is a world-leading provider of technologies for environmental, process, appearance and performance applications. For more information about Engelhard environmental solutions, call us or visit us on the web at [www.engelhard.com/environmental](http://www.engelhard.com/environmental).

Engelhard seeks to prevent reliable information concerning the composition, properties and use of its products, services and processes. However, all literature, advice and other material concerning any product, service or process or its selection or use is provided AT NO CHARGE AND WITH NO WARRANTY OF ANY KIND. All sales are subject to Engelhard's Terms and Conditions of Sale, which are reproduced on the reverse side of each invoice. ALL WARRANTIES OF MERCHANTABILITY AND FITNESS OF PURPOSE ARE DISCLAIMED. Remedies for any breach and Engelhard's liability, including that for patent infringement, are limited as provided in Engelhard's Terms and Conditions of Sale. Engelhard is not liable for consequential, incidental, or special damages. Nothing should be construed as a recommendation or inducement to infringe any patent. No assumption should be made that all safety or environmental protection measures are indicated, or that other measures may not be required. DPF™ is a trademark of Engelhard Corporation.  
EO-8311 Rev. 09/04

Figure 1

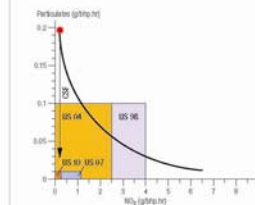


Figure 2

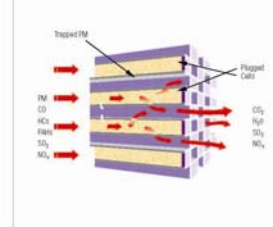
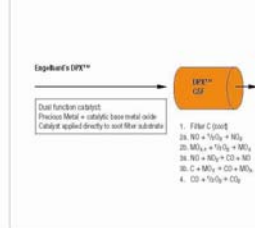
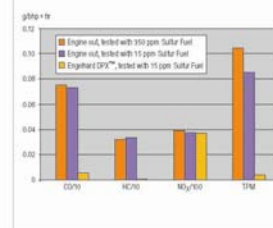


Figure 3



Typical Engelhard DPF™ emissions reduction performance



ENGELHARD

Change the nature of things.

Engelhard Corporation  
101 Wood Avenue  
Iselin, NJ 08830-0770  
Telephone: 732 205-5000  
Fax: 732 321-1161  
Web site: [www.engelhard.com](http://www.engelhard.com)



# Front End Loaders



- 29 units equipped with oxidation catalysts (up to 60% reduction in emissions)
- Featured at USEPA "Air Innovations" Conference



# Donaldson DOCs



Donaldson.

## Cost-effective & efficient solutions from Donaldson

### DPF Technology

#### Diesel Particulate Filters (DPF)

Donaldson DPFs remove more than 85%+ of diesel particulate matter (PM). They are a direct replacement for most OEM Mufflers, but they are more complicated to install and have special engine requirements in order to properly filter our emissions. Fifteen models are available to cover 90% of the bus and on-road truck applications.



**DPF Solution #1**  
85%+  
Emissions Reduction

**DPF & Spiracle<sup>®</sup> Solution #2**  
90%+  
Emissions Reduction

### Crankcase Emissions Technology

#### Donaldson Spiracle<sup>™</sup>

The Spiracle<sup>®</sup> filtration system eliminates 100% of crankcase emissions for the following engine applications:

- Medium-duty trucks, buses, mid-size off-road equipment
- Heavy-duty trucks, large-size off-road and industrial generator sets



#### Durable and Warranted

- Powder-coated metallic housing for durability and heat resistance

#### Design Features

- Replaceable two-stage filter offers the highest level of filtration efficiency (90%+). Filter change out is at every oil change (25,000 miles) or every 500 hours of operation, whichever comes first.
- Pressure relief valve prevents pressure build-up in the crankcase when the service filter is fully loaded
- Bottom-drain oil sump connection returns coalesced oil to the engine
- Check valves prevent evacuation of lube oil from engine sump in the event of a vehicle/engine roll over

#### Easy to Service

- Top-load design improves serviceability
- Over-center latches allow easy access to service filter

#### Other Unique DPF & DOC Muffler Design Features

- Integral pressure flow distribution device
- enhance catalyst performance
- delivers uniform airflow and temperatures across the entire catalyst
- reduces exhaust backpressure
- Meets U.S. Federal noise regulations with integrated resonators and attenuation devices

2 Diesel Emissions Solutions

... solutions that meet the requirements of the U.S. EPA Voluntary Retrofit Program and CARB's Diesel Risk Reduction Program<sup>1</sup>.

**DOC & Spiracle<sup>®</sup> Solution #3**  
25-50%  
Emissions Reduction

### DOC Technology

#### Diesel Oxidation Catalyst (DOC) Mufflers

Donaldson DOC mufflers remove 15-30% of diesel PM and are a direct replacement for most OEM mufflers. Models cover 90% of the bus and on-road truck applications.

#### DOC Mufflers Are Approved For:

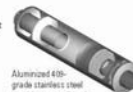
- 1988 and newer four-stroke diesel on-road engines
- engine horsepower ranges of 150-600 hp
- most exhaust configurations, including singles and duals
- acceptable fuel types: Federal (500 ppm sulfur) or ULSD (15 ppm sulfur)

#### Easy to Install

- Direct replacement for most OEM mufflers<sup>2</sup>

#### Service & Maintenance

- Little or no maintenance



**DOC Muffler<sup>®</sup> Solution #4**  
15-30%  
Emissions Reduction

#### Emissions Solution Selection Considerations

	DOC Muffler and Spiracle CCFs	DOC Muffler	DOC Muffler and Spiracle CCFs	DOC Muffler
PM Reduction	80%+	85%+	25-50%	15-30%
Reduces	Hydrocarbons, Soluble Organic Fraction	Carbon Monoxide		
Activation Temperature	200°C	150°C		
Allowable Fuel	ULSD Only (\$2,500-3,000/year fuel penalty)	Federal and ULSD		No ULSD Fuel Penalty

- The DPF and Spiracle combination is not self-certified by EPA or CARB.
- These products are protected internationally by patents, trademarks, and design registrations, both issued and pending.
- Higher horsepower engines (400 hp) may need larger diameter DOC mufflers or dual DOC mufflers to accommodate the higher airflow and backpressure associated with these engines.
- Dispose according to local regulations.
- The DOC Muffler is EPR certified.

Diesel Emissions Solutions 3

### Cost Effective Emissions Solutions for Diesel Engines



Increasing public pressure and regulations are reducing allowable emissions for diesel engines. Other regions will require retrofits to meet the latest requirements.

Donaldson has EPA-certified solutions, air installation services networks, and local Donaldson representatives that are ready to help you select the best solution for your fleet.

#### Cost Comparison<sup>1</sup>

Based on 1994 & 1995 Engine Emissions Reduction Program

Emissions Solution	1994		1995		1996		1997		1998		1999	
	PM	CO	PM	CO	PM	CO	PM	CO	PM	CO	PM	CO
Engine Emissions	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Exhaust Emissions	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Total Emissions Reduction	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Cost	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
Cost per unit of emissions reduced	\$25	\$25	\$25	\$25	\$25	\$25	\$25	\$25	\$25	\$25	\$25	\$25

Your most cost-effective emissions solution is a Donaldson DPF Muffler combined with a Spiracle crankcase emission filtration system.

Conclusion...Donaldson has your solution!

<sup>1</sup>These data are estimates and are for comparative purposes only. Actual prices may vary.



Donaldson Companies, Inc.  
2000 North 17th Avenue  
P.O. Box 100  
Scottsdale, AZ 85267  
www.donaldson.com

# Installed on 76 Refuse Trucks & 29 Loaders

# Alternate Fuel and Hybrid Fleet



- 58 hybrids sedans (33 City owned and 25 leased)
- 77 hybrid SUV's, with an additional 22 hybrid SUV's to be delivered within the month (May 2006)

- 192 Ethanol (E-85) light duty vehicles
- 78 Compressed Natural Gas powered vehicles, including 2 newly re-powered CNG refuse trucks, equipped with Cummins Westport #CG-275 engines







# **Mayor Daley's Challenge to the Department of Fleet Management ---**

**Help make Chicago the  
“greenest” city in the nation!**



**Here are some of the other steps we've taken to meet the Mayor's challenge –**

**Completed construction of 2 Green Mega Fuel Sites**

- **Natural storm water controls**
- **Petroleum-resistant plants**
- **Solar-powered panels**
- **Storm water runoff prevention**



# **City of Chicago**

## **Department of Fleet Management**



### **Using environmentally friendly products**

- **Non-chlorinated and/or biodegradable part cleaners**
- **Degreasers**
- **Lubricants**
- **Penetrating oils, and all-natural solvents**

# **City of Chicago**

## **Department of Fleet Management**

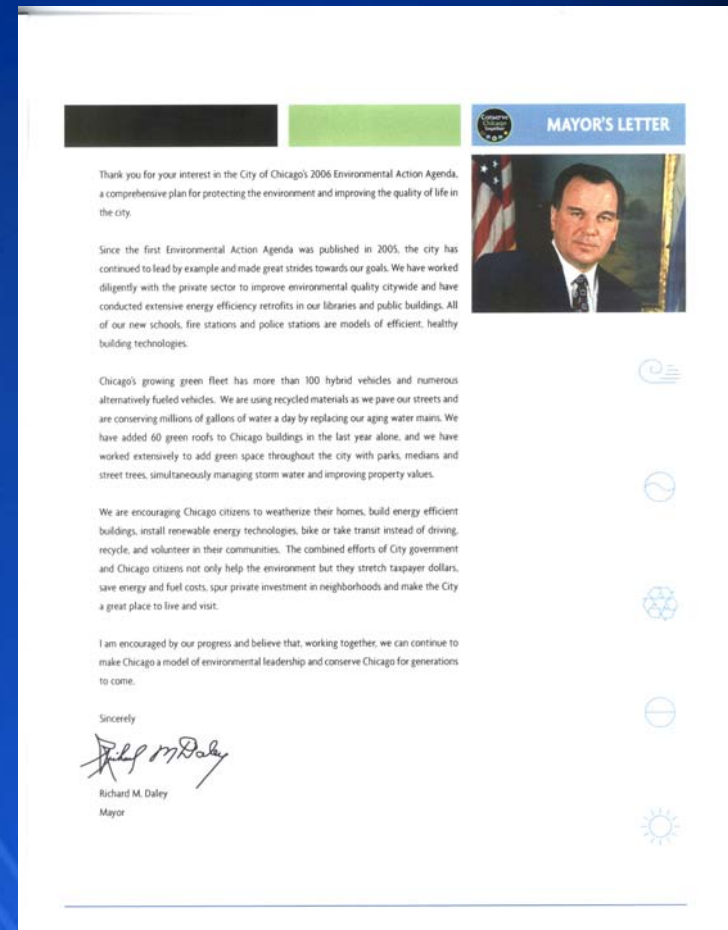
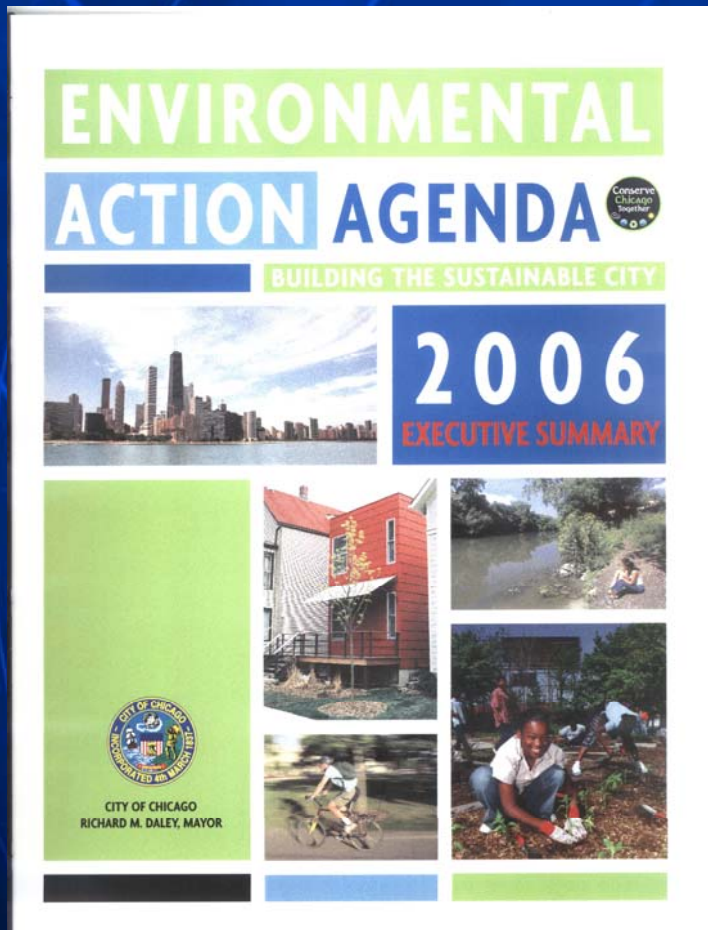


### **Goals for the future**

- **Increase size of alternative fuel / hybrid fleet by 10% annually**
- **Expand the diesel engine retrofit program**
- **Expand availability of E-85 fuel**
- **Expand shop material recycling program**
- **Develop and deploy the world's first hybrid refuse truck**
- **Build and operate the world's first ethanol-to-hydrogen fueling station**
- **Explore fuel cell vehicle technology**



Get complete details at the City's website:  
[cityofchicago.org](http://cityofchicago.org) (Dept. of Environment)





**Thank you for your attention.**

**Howard Henneman**

**Commissioner of Chicago Dept. of Fleet Management**

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**Special thanks to Eileen Joyce, Kevin Campbell, Bethany Kraseman and Brian Loll for their creativity and assistance .**